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3,070,166

PREVENTION OF EROSION OF FLOW TUBINGS IN OIL AND GAS WELLS

Filed Oct. 24, 1960

2 Sheets-Sheet 1.

FIG. 1.

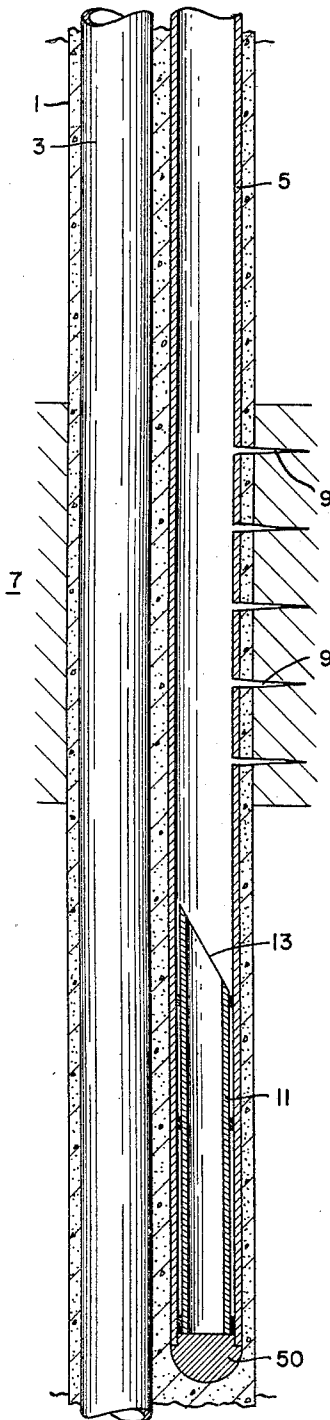


FIG. 2.

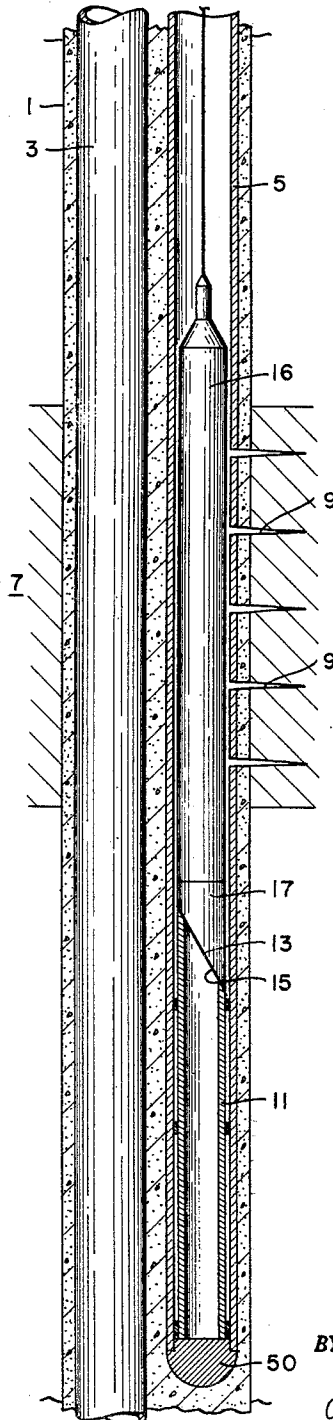
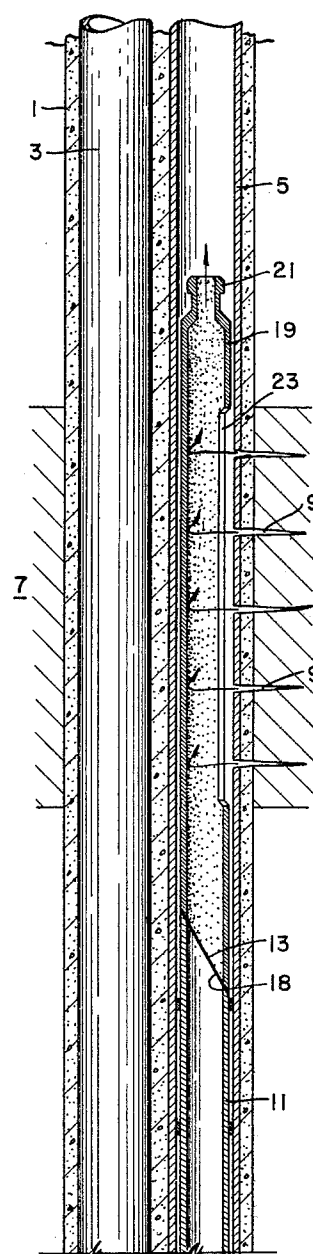


FIG. 3.



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FIG. 5.

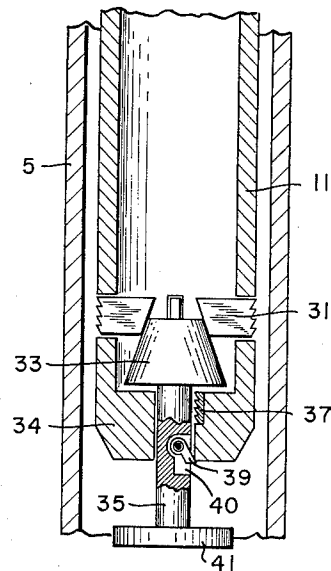
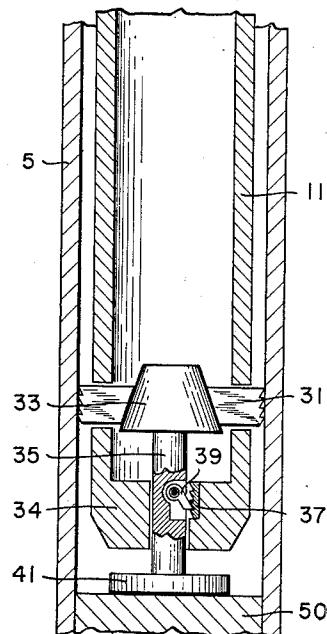


FIG. 6.



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FIG. 4.

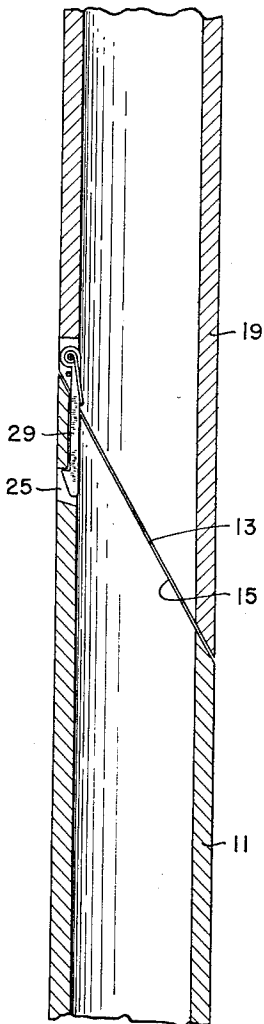
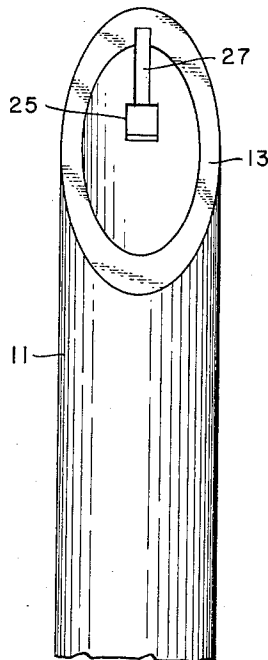


FIG. 7.



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PREVENTION OF EROSION OF FLOW TUBINGS IN
OIL AND GAS WELLS

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This invention relates generally to production of hydrocarbonaceous earth materials through wells in the earth, and more particularly to the prevention of erosion of the interiors of production pipe strings by abrasive-laden fluids from earth formations.

In a conventional oil well installation, a pipe string is cemented to the sides of a borehole to serve as a borehole liner for the purpose of preventing the sides of the borehole from caving in. One or more production pipe strings, or flow tubings, are suspended from a wellhead apparatus, the number of production pipe strings depending on the number of earth formations to be produced through the well bore. In some areas it has been found practical to eliminate the borehole lining, or casing, and to cement production pipe strings directly to the walls of the borehole. The cementing operation is necessary to prevent fluid communication between productive earth formations and to prevent contamination of fresh water sands near the earth's surface by hydrocarbonaceous fluids. After the production pipe strings have been cemented they are perforated to open fluid communication between the productive earth formations and the interiors of the pipe strings. Inasmuch as it is desirable to have only one pipe string in fluid communication with a given earth formation, various techniques have been developed for the purpose of preventing the accidental perforation of two pipe strings at the same level so as to open up fluid communication between pipe strings.

It is well known that sand and other abrasive materials may be produced along with earth formation fluids. Often the formation fluids are produced at a high velocity so as to impart sufficient kinetic energy to the abrasive particles that they will erode away the interior of the pipe string opposite the perforations in the pipe string and cement. This erosion is particularly undesirable when the perforations are in a direction opposite to an adjacent pipe string in a multiply completed well. It is manifest that if the erosion were continued for a sufficiently long interval of time, fluid communication could be opened up between the production pipe strings. Under any circumstances, the erosion is most undesirable.

The present invention contemplates the insertion in a production pipe string of a substantially tubular sleeve of erosion resistant material, such as a ceramic material, and of an orienting device which is fixedly positioned in the pipe string. The orienting device may be anchored in the pipe string either before or after it is lowered into the well. An impression block, which may be formed from a soft metal, is lowered into the pipe string adjacent the perforations therein. It is important that both the impression block and the tubular sleeve be adapted to be oriented within the pipe string by means of the orienting device. After the impression block has been oriented within the pipe string by means of the orienting device, the well is produced for a short time interval so that abrasive-laden earth fluids may impinge on and partially erode the impression block. The impression block is retrieved from the well, and a window is cut in the erosion resistant sleeve at a location corresponding to the location of the erosion on the impression block, assuming that both the impression block and the sleeve are similarly oriented. The sleeve is then lowered in the short

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pipe string adjacent the perforations therein and oriented by means of the orienting device. The well may then be produced and the earth fluids and abrasive earth particles will pass through the window to impinge on the interior of the abrasive resistant sleeve. Should the abrasive sleeve wear away after a period of time, it may be readily replaced.

The invention will be more completely described with reference to the accompanying drawings, wherein:

FIGS. 1, 2, and 3 are diagrammatic representations of an oil well installation, the various figures illustrating steps in the method of the invention;

FIGS. 4 and 5 are cross-sectional views illustrating the preferred embodiment of the abrasive-resistant sleeve and the orienting means illustrated in FIG. 3;

FIG. 6 is a view similar to FIG. 5 illustrating the actuated position of the apparatus illustrated in FIG. 5; and

FIG. 7 is a side view of the orienting device illustrated in FIG. 4.

With reference now to FIGS. 1, 2, and 3 there is shown a borehole 1 in the earth penetrating a hydrocarbonaceous earth formation 7 and other hydrocarbonaceous earth formations (not shown) below earth formation 7. Production pipe strings 3 and 5 coextend from the earth's surface in side-by-side relationship and are assumed to have been cemented to the sides of the borehole 1 and to have been perforated to open up fluid communication between productive earth formations and the interiors of the pipe strings. Pipe string 5 is illustrated as having been perforated so as to produce earth formation 7. One or more perforations 9 extend from the pipe string 5 through the cement around the pipe string and into the earth formation 7. Production pipe string 3 is assumed to be for the purpose of producing a productive earth formation below formation 7.

Production pipe string 5 is closed at its lower end by a bull plug 50. An orienting device 11 is shown as a sleeve welded to the interior of pipe string 5 between the bull plug 50 and the perforations 9. The orienting device is illustrated as having a slanting upper face 13. The orienting device may be a solid piece of metal or other material, but is here illustrated as being tubular for the purpose of making the apparatus as economical as possible. The exact orientation of the slanting upper face 13 within the pipe string 5 is not critical.

The perforations 9 are illustrated as being oppositely disposed relative to pipe string 3. It is manifest that if abrasive-laden fluids from earth formation 7 were to impinge on the interior of the pipe string 5 so as to erode away the inner wall thereof in due course of time, the cement between the pipe string would also be worn away and the particles would impinge on the exterior of pipe string 3. Ultimately, this would erode a hole through pipe string 3 to open up fluid communication between pipe strings 3 and 5.

Manifestly, it is necessary to determine the relative orientations of orienting device 11 and the direction in which the perforations 9 are facing. This is done by lowering into the pipe string 5 an impression block 16. The impression block is an elongated body of a material that is pliant and easily eroded relative to materials such as steel or rubber. The material must be substantially nonreactive with well fluids. Suitable materials for the purpose are lead and certain plastics. The impression block should be substantially cylindrical in shape and should have a slanting or inclined lower face 15 that is complementary to the slanting upper face of the orienting device 11. The inclined upper face of the orienting device 11 and the inclined lower face of impression block 16 should make a predetermined angle with the horizontal and with the longitudinal axes of the pipe string 5.

The earth formation 7 is now produced so that abrasive-laden fluids from formation 7 will flow through perforations 9 and will strike the impression block 16. Production is continued for a short interval of time, only long enough for a number of definite impressions to be eroded into the impression block that are indicative of the locations of perforations 9 relative to the direction of slant of the slanting face of the impression block.

The impression block 16 is retrieved from pipe string 5, and the positions of the indentations therein produced by the erosive formation fluids relative to the direction of slant of the lower face 15 is noted. A ceramic sleeve 19 (see FIG. 3) having substantially the same dimensions as the impression block 16 and having an inclined lower face 18 that also complements the inclined upper face 13 of orienting device 11, is provided with a slot or window 23. The position of the slot or window 23 relative to the direction of slant of lower face 18 is substantially the same as the position of the indentations in the impression block relative to the direction of slant of the lower face 15 of the impression block. The abrasive-resistant sleeve 19 is lowered into the production pipe string 5 by a wireline having a fishing head (not shown) which is secured to a fishing neck 21 on the abrasive-resistant sleeve 19. The abrasive-resistant sleeve is oriented on the orienting device 11; the window 23 will be in alignment with the perforations 9 so that earth formation fluids passing through perforations 9 will strike the interior of the sleeve. It is manifest that the sleeve can be easily replaced.

FIGS. 4 and 7 illustrate certain details of construction of the abrasive-resistant sleeve 19 and the orienting device 11. The orienting device 11 is provided with a notch 25 near the upper end thereof and a slot 27. The notch 25 may extend through the walls of the tubular orienting device 11. A spring-biased, pivoted latch member 29 is affixed to the lower end of abrasive-resistant sleeve 19 at a position such that when the inclined upper face 13 of orienting device 11 and the inclined lower face 15 of the abrasive-resistant sleeve 19 are in alignment, the latch means will snap into place in slot 27 and notch 25.

FIGS. 5 and 6 illustrate apparatus for securing the orienting device in the production pipe string 5 after the pipe string has been lowered into the well. The apparatus may comprise two or more axially movable slip members 31 adapted to move radially from the orienting device 11 so as to dig into the sides of the production pipe string 5. A truncated conical member 33 bears against the slips 31 so as to force the slips outwardly from the orienting device 11. The shaft 35 affixed to the truncated conical member 33 extends through the closed end 34 of the orienting device 11. A foot plate 41 is affixed to the lower end of shaft 35. A pivoted dog 39 in a notch or recess 40 within shaft 35 is adapted to pivot into notches in notched member 37 so as to hold the shaft 35 and truncated conical member 33 against downward movement relative to orienting device 11. Thus, when the orienting device is dropped into the well, the foot plate 41 will strike bull plug 50 to force truncated conical member 33 upwardly and slips 31 outwardly. Latch member 39 and notch member 37 will hold the orienting device 11 against upward movement so that the orienting device 11 will be rigidly connected to the production tubing by means of the slips 31.

The invention provides method and apparatus for effectively preventing erosion of production pipe strings used in tubingless completed well installations. In the event that the abrasive-resistant sleeve provided by the invention should erode away during the course of time, it may be readily replaced at minimum expense. The fact that all of the apparatus can be manipulated by means of wireline techniques further reduces the costs of initial installation and maintenance.

The invention is not to be restricted to the specific structural details or arrangement of parts, as various modifications thereof may be effected without departing from the spirit and scope of this invention.

The objects and features of the invention having been completely described, what is claimed is:

1. In a well in the earth including a production pipe string cemented to the sides of a borehole, and perforated to open fluid communication to earth formations surrounding the borehole, wherein said pipe string has disposed therein orienting means for orienting well tools lowered thereinto, the method of preparing the well for production of earth fluids, comprising: lowering an indentable, erodable impression block into the pipe string adjacent the perforations therein; with the orienting means, orienting the impression block in the pipe string; producing the well through the pipe string for a time interval of sufficient duration to erode indentations into the impression block opposite the perforations; retrieving the impression block from the well; at the earth's surface, forming a window in a tubular, abrasive-resistant sleeve at a location opposite to the location thereon corresponding to the eroded area of the impression block assuming that the sleeve and the block are in their oriented positions in the pipe string; and orienting the sleeve in the pipe string at the level of the perforations with said orienting means.

2. In a well in the earth including a production pipe string cemented to the sides of a borehole, and perforated to open fluid communication to earth formations surrounding the borehole, wherein the pipe string has disposed therein orienting means for orienting well tools lowered thereinto, the method of preparing the well for production of earth fluids, comprising: with said orienting means, orienting an impression block in the pipe string at the level of the perforations in the pipe string; producing said well through said pipe string for a time interval of sufficient duration to erode impressions in the impression block opposite the perforations in the pipe string; and removing said impression block from the well; forming a window in a tubular, abrasive-resistant sleeve in the position on the sleeve opposite to the location thereon corresponding to the position of the impressions in the impression block, assuming that the impression block and the sleeve are substantially identically oriented; and, with said orienting device, orienting the sleeve in the pipe string at the level of the perforations therein.

3. In a well in the earth including a production pipe string cemented to the sides of a borehole, and perforated to open fluid communication to earth formations surrounding a borehole, the method of preparing the well for production of earth fluids, comprising: measuring the position of the perforations in the pipe string relative to a predetermined orientation from within the pipe string; at the earth's surface, forming a window in a tubular, abrasion-resistant sleeve corresponding to the position of the perforations relative to the predetermined orientation assuming the sleeve to be oriented within the pipe string according to said predetermined orientation; and orienting the sleeve within the pipe string according to said predetermined orientation to align the window and the perforations.

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